

Our results of high tibial osteotomy in medial knee osteoarthritis

Open wedge high tibial osteotomy in medial knee osteoarthritis

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Abstract

Aim: Knee osteoarthritis is very common and causes serious dysfunction of the joint. HTO is the most commonly used method in cases of active and young patients suffering from medial knee osteoarthritis. Although many techniques have been described for HTO, opening-wedge osteotomy is the most commonly used method. Given the rare availability and osteointegration of the allograft, autograft use is more common. In our clinic, we prefer using ipsilateral autografts. Grafts of different sizes were taken for each patient. In this study, we aimed to introduce this procedure and investigate the effect of surgical treatment on outcome.

Material and Methods: WOMAC, Lysholm score, knee ROM, and mechanical axis were evaluated in 32 patients with a mean age of 53 years. We fixed the mechanical axis using the lamina spacer and cable method during HTO surgery. After autograft placement, we provided fixation with a locked T-plate.

Results: While there was a statistically significant improvement in WOMAC, Lysholm score, and mechanical axis values, there was no significant difference in ROM value. Good and excellent results were achieved in all patients except one.

Discussion: The rate of excellent results increases in younger patients, which is consistent with the literature. HTO, which is applied with appropriate patient selection and the right technique, can be used safely and successfully in knee medial osteoarthritis. In HTO surgeries performed in our clinic, we take autografts of different sizes according to the degree of correction in each patient. We think that this autograft retrieval technique facilitates surgery and contributes to stability.

Keywords

Knee Medial Osteoarthritis, High Tibial Osteotomy, Autograft

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Introduction

Osteoarthritis is a progressive disease that occurs upon the destruction of articular cartilage [1]. Knee osteoarthritis is very common and causes serious dysfunction of the joint [2]. Methods such as arthroscopy, high tibial osteotomy (HTO) and partial and total arthroplasty have been described for this condition [3,4]. HTO is the most commonly used method in cases of active and young patients suffering from medial knee osteoarthritis [5]. Although many techniques have been described for HTO, the most commonly used methods are opening-wedge and closing-wedge osteotomies are [6]. Among these, opening-wedge osteotomy is more advantageous since it requires only a single incision and not fibula osteotomy [7].

The stability problem in opening-wedge osteotomy has been largely resolved with the use of locking plates. However, there are studies reporting that stabilization is improved with the use of a wedge-shaped allograft [8]. Given the rare availability and osteointegration of the allograft, autograft use is more common. In our clinic, we prefer using ipsilateral autografts. We follow a non-standard procedure during the collection of the autograft from the iliac bone and its application. In this study, we aimed to introduce this procedure and investigate the effect of surgical treatment on outcome.

Material and Methods

Our study was commenced upon obtaining the approval of our hospital's ethics committee (date: 06/05/2021, no: 1389). Patients who were admitted to our hospital with knee medial osteoarthritis between 01/06/2019 and 01/12/2021 and operated using medial opening-wedge osteotomy (MOWO) were evaluated retrospectively. All surgeries were performed by a single physician. Those with a follow-up period of <6 months were excluded from the study. Patients with medial osteoarthritis of the knee were classified according to the preoperative Kellgren–Lawrence Radiological Criteria. Those classified as stage 4 were excluded from the study.

In the study, preoperative preparation and postoperative control were performed using an orthorotronogram that included the hip and ankle.

Surgical technique

After spinal anesthesia was applied to the patient, the surgery was started using a tourniquet in the supine position. An oblique incision was made medial to the knee to access the anterior edge of the medial collateral ligament (MCL). The MCL was retracted posteriorly, and an oblique K-wire was inserted under the guidance of fluoroscopy, starting from the medial and targeting the fibular head laterally. After positioning the knee in 15° flexion, another K-wire was sent 1 cm anterior to the fibular head, ensuring that both wires were visible one over the other on the coronal plane. After control with scopy, osteotomy was performed with sharp-ended osteotomes until 0.5 cm to the lateral cortex of the tibia. The amount of correction of the mechanical axis was decided using the cable technique [9]. The lamina separator was placed posterior to the osteotomy line. The cable was distracted with a lamina separator until it reached the Fujisawa point [10]. The MCL was partially loosened in patients who had difficulty in distraction. SLOP control was performed by taking a side view of the knee with fluoroscopy.

The opened osteotomy line was measured anteriorly and posteriorly with a ruler. Two wedge-shaped tricortical grafts were removed from the ipsilateral iliac bone and nailed to the osteotomy line. Grafts of different sizes were taken for each patient, with the measurements made at the osteotomy line being the base of the triangular grafts. After the grafts were nailed, the lamina separator was removed. The fix performed was not impaired. (Figure 1). The T- plate was then fixed with locking screws. Finally, scopy control was performed, and the operation was terminated (Figure 2).

Patients were called for follow-up visits at 3, 6, and 3 months. The patients were followed up for at least 6 months.

For radiological evaluation of the patients, preoperative and postoperative femorotibial angles were measured. For functional evaluation, the Lysholm score was measured in the preoperative period and at the postoperative sixth month. WOMAC (Western Ontario and McMaster Universities Arthritis Index) scoring was used for pain control. These values were assessed statistically. Patients whose union was later than 12 weeks were considered to have delayed union.

Statistical analysis

The SPSS (Statistical Package for the Social Sciences) 23.0 package program was used for statistical analysis of the data. Continuous measurements were summarized as mean and standard deviation (median and minimum-maximum, wherever appropriate). The Shapiro–Wilk test was used to establish whether the parameters in the study showed normal distribution. The Wilcoxon test was used to assess the patients for variance in preoperative and postoperative measurements of the mechanical axis, Lysholm score, and joint-range values. Spearman's correlation test was used to identify whether variations in these measurements were related to the age, weight, and body mass index (BMI) of the patients,. Statistical significance level was set as 0.05 in all tests.

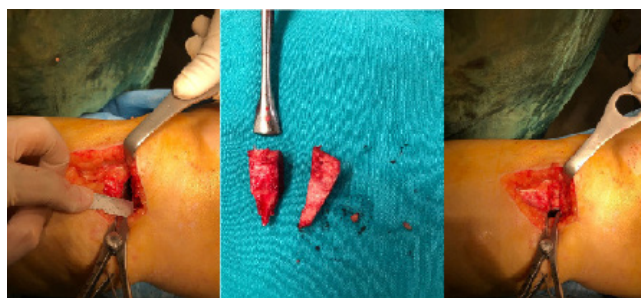


Figure 1. Measurement of the osteotomy line, visualization of the grafts, images of the graft placed in the defect



Figure 2. Preoperative AP x-ray, planning by cable method, postoperative x-ray

Results

A total of 32 patients were enrolled in the study, including 26 women and 6 men. Their mean age was 53 (43–64) years. The patients had a mean weight of 79 (73–88) kg and a mean BMI of 25 (23–28). Demographic characteristics of the patients are listed in Table 1.

According to the Kellgren–Lawrence Radiological Criteria, 50% of the patients were in stage 2 and 50% were in stage 3.

Table 1. Introductory characteristics of the patients

	Mean (Min–Max)
Age	53 (43–64)
Weight	79,8 (73–88)
Body mass index	25,3 (23–28)
Smoking (smokers/total)	7,32

Table 2. Preoperative and postoperative findings of mechanical axis, Lysholm score, and joint ROM (Range of motion) (varus accepted as a minus value in the mechanical axis measurement)

	Mean ± SD
Preoperative mechanical axis	-9,53 ± 1,93
Postoperative mechanical axis	4,91 ± 1,22
Preoperative Lysholm Score	67,25 ± 4,79
Postoperative Lysholm Score	90,28 ± 5,53
Preoperative joint ROM	124,5 ± 2,42
Postoperative joint ROM	122,91 ± 2,33
Preoperative WOMAC	39,58 ± 3,25
Postoperative WOMAC	12,5 ± 1,13

Table 3. Differences between preoperative and postoperative findings of mechanical axis, Lysholm score, and joint ROM (Range of motion)

	Preoperative Mean ± SD	Postoperative Mean ± SD	P*
Mechanical axis	-9,53 ± 1,93	4,91 ± 1,22	<0.001
Lysholm Score	67,25 ± 4,79	90,28 ± 5,53	<0.001
WOMAC Score	39,58 ± 3,25	12,5 ± 1,13	<0.001
Joint ROM	124,5 ± 2,42	122,91 ± 2,33	0,162

* p < 0.05, Wilcoxon test



Figure 3. The patient who was excluded from the study because she was stage 4 according to the Kellgren–Lawrence Criteria. Preoperative and postoperative x-ray

Good results were also obtained in the patient who was excluded from the study because she was stage 4 according to the Kellgren–Lawrence Criteria, but was operated on because she was 42 years old (Figure 3).

Preoperative mechanical axis varus was 9.53(±1.93) degrees, and the postoperative valgus was 4.91(±1.22). While the preoperative Lysholm score was 67.25 (±4.79), it was 90.28 (±5.53) postoperatively. According to the Lysholm score, 15 of the 32 patients had excellent results, 16 had good results, and 1 patient had a moderate result. While the WOMAC SCORE was 39.6 preoperatively, it was lowered to 12.5 at the postoperative 6th month. The timely union was observed in all patients except one. No embolism or wound problem was observed in any of the patients. Weight-bearing was started at the 6th week, and unassisted walking was begun at the 12th week. The knee joint range of motion (ROM) was measured as 124.5(±2.42) preoperatively and 122.91(±2.33) postoperatively (Table 2).

Postoperative measurements of the mechanical axis ($p < 0.001$) and postoperative Lysholm scores were found to be significantly higher ($p < 0.001$) than preoperative scores. WOMAC SCORE was found to be significantly lower in the postoperative period ($p < 0.001$) than that in the preoperative period. There was no significant difference in the postoperative measurements of joint ROM ($p < 0.001$) when compared with the preoperative period (Table 3).

Discussion

The technique is known to alleviate pain by reducing the load on the medial compartment by correcting the mechanical axis. In addition, there are publications showing that HTO contributes to pain reduction by alleviating medial meniscus extrusion [11]. The risk of peroneal nerve injury in closing-wedge osteotomy is eliminated with the technique of opening-wedge osteotomy [12]. In a study by Gupta et al. in 2019, it was concluded that in a patient who is scheduled for ACL reconstruction, HTO should be considered in addition to ACL reconstruction if the SLOP value is >12 degrees. In this study, the authors emphasized the importance of the increase in SLOP in the sagittal plane as well as the varus deformity in the coronal plane [13]. There is a possibility to correct SLOP in open wedge osteotomy.

Locking plates and peek plates are currently used in osteotomy fixation [14–16].

While collapse of the wedge part opened in the long term was previously a significant problem, the use of locking plates resolved this problem to a great extent. In a study comparing opening-wedge osteotomies using a titanium locking plate with and without grafting, no difference was found between the two groups [17]. On the other hand, in a biomechanical study conducted by Belsey et al. in 2019, researchers compared groups of synthetic wedge grafting, allograft wedge grafting, and the use of plate without grafting on the osteotomy line. The grafted groups were consistent with each other and were more robust than the non-grafted groups [18]. Donor site problems may occur with the use of autografts. However, many clinics prefer autografts since their use is associated with an increased potential for union and the fact that allografts are difficult to access for economic reasons.

As can be understood from the preceding sections, the factors

affecting surgical success in opening-wedge osteotomy can be summarized as osteotomy technique, graft use, and fixation material.

The autografts used in our study were recovered from the iliac bone in a size unique for each case by measuring the gap in the osteotomy line. We are of the opinion that the graft recovered in this manner contributed to stability.

In a study published in 2020, Chuaychoosakoon et al. emphasized the importance of SLOP preservation during the surgical technique and reported that they solved this problem with a distraction tool developed using 4 K wires, two wires at the proximal and two at the distal part of the osteotomy [19]. A classical distractor was used in our study. SLOP control was achieved using scopy once a suitable position was obtained according to the Fujisawa point with the cable method. Subsequently, the anterior and posterior spaces of the osteotomy were measured. Based on these measurements, two wedge grafts were recovered from the iliac bone and nailed to the osteotomy line. Even after the distractor was removed, it was observed that the correction remained intact. Thus, the distractor was prevented from causing difficulties in plate placement. We think that this grafting method will be beneficial for those who are unable to access the distraction tool developed by Chuaychoosakoon et al. We obtained similar results with this study.

In the osteotomy technique, the most important points are to make the osteotomy as close as possible to the varus deformity in the proximal tibia and to stop the osteotomy half a centimeter to the lateral cortex. In one of our cases, although we thought that the required correction was intraoperatively achieved, the mechanical axis remained at zero degrees in the postoperative x-ray. While the intraoperative correction was good, we attribute this loss of correction after surgery to a fracture of the lateral cortex. Being the only one who had moderate success according to Lysholm scoring and delayed union in our study, this patient is the one referred to have a fractured lateral cortex.

In the study by Sarman et al. in 2019, titanium wedge plates produced for opening-wedge osteotomy were studied and their success was mentioned [17]. The wedge thickness of these plates was adjusted according to the osteotomy opening, but the anterior and posterior thicknesses of the wedge were equal. When the sagittal plane correction is made in patients with a large SLOP angle, the osteotomy line is opened differently in the anterior and posterior regions; hence, the wedge plate becomes incompatible [17]. It would be more appropriate to use a locked T plate in SLOP corrected HTO surgeries. In this study, a locking T plate was used, which yielded satisfactory results. The limitations of our study are that there was no control or comparison group, and that the follow-up period was short.

When we excluded the only patient with delayed union, all others had good and excellent results according to the Lysholm scoring. The mean age of the patients with excellent results was 51.4, while the mean age of those with good results was 54.5. The contribution of the mean age to surgical success is consistent with the literature. When BMI values were compared, it was 25.33 in patients with excellent results and 25.25 in patients with good results. We attribute the lack of significant

difference to the fact that this surgical method was not applied in obese patients.

Only an angled adjustable knee brace was used postoperatively. In this way, early initiation of movement prevented loss of joint range of motion.

In a study conducted in 2021 in which total knee prostheses PCL sparing and PCL sacrificing were compared, range of motion was significantly higher in the group with PCL preservation. This result revealed the importance of intra-articular structures. For this reason, it suggests that one should be more courageous when deciding on HTO, which is joint-sparing surgery [20].

Conclusions

In conclusion, MOWO using a titanium locking plate can be performed safely and with very good results in patients under 55 years of age and with stage 2–3 medial knee osteoarthritis according to the Kellgren–Lawrence Criteria. If autograft is to be used, the use of the graft as described in our study is likely to contribute to the success of the surgery.

Scientific Responsibility Statement

The authors declare that they are responsible for the article's scientific content including study design, data collection, analysis and interpretation, writing, some of the main line, or all of the preparation and scientific review of the contents and approval of the final version of the article.

Animal and human rights statement

All procedures performed in this study were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. No animal or human studies were carried out by the authors for this article.

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Conflict of interest

None of the authors received any type of financial support that could be considered potential conflict of interest regarding the manuscript or its submission.

References

- Dieppe P. Developments in osteoarthritis. *Rheumatology (Oxford)*. 2011;50(2):245-7.
- Maheu E, Bannuru RR, Herrero-Beaumont G, Allali F, Bard H, Migliore A. Why we should definitely include intra-articular hyaluronic acid as a therapeutic option in the management of knee osteoarthritis: Results of an extensive critical literature review. *Semin Arthritis Rheum*. 2019;48(4):563-72.
- Doma K, Grant A, Morris J. The Effects of Balance Training on Balance Performance and Functional Outcome Measures Following Total Knee Arthroplasty: A Systematic Review and Meta-Analysis. *Sports Med*. 2018;48(10):2367-85.
- Lee YS, Kim HJ, Mok SJ, Lee O-S. Similar Outcome, but Different Surgical Requirement in Conversion Total Knee Arthroplasty following High Tibial Osteotomy and Unicompartmental Knee Arthroplasty: A Meta-Analysis. *J Knee Surg*. 2019;32(7):686-700.
- Lu J, Tang S, Wang Y, Li Y, Liu C, Niu Y, et al. Clinical Outcomes of Closing and Opening-Wedge High Tibial Osteotomy for Treatment of Anteromedial Unicompartmental Knee Osteoarthritis. *J Knee Surg*. 2019;32(8):758-63.
- Kim JH, Kim HJ, Lee DH. Leg length change after opening wedge and closing wedge high tibial osteotomy: A meta-analysis. *PLoS One*. 2017;12(7):e0181328.
- Hoell S, Suttmoeller J, Stoll V, Fuchs S, Gosheger G. The high tibial osteotomy, open versus closed wedge, a comparison of methods in 108 patients. *Arch Orthop Trauma Surg*. 2005;125(9):638-43.
- Belsey J, Dikko Kaze A, Jobson S, Faulkner J, Maas S, Khakha R, et al. The biomechanical effects of allograft wedges used for large corrections during medial opening wedge high tibial osteotomy. *PLoS One*. 2019;14(5):e0216660.
- Krettek C, Miclau T, Grün O, Schandelmaier P, Tschern H. Intraoperative control of axes, rotation and length in femoral and tibial fractures. *Technical note. Injury*. 1998;29 (Suppl 3):S29-39.
- Fujisawa Y, Masuhara K, Shiomi S. The effect of high tibial osteotomy on osteoarthritis of the knee. An arthroscopic study of 54 knee joints. *Orthop Clin North Am*. 1979;10(3):585-608.
- Astur DC, Novaretti JV, Gomes ML, Rodrigues AG, Kaleka CC, Cavalcante ELB, et al. Medial Opening Wedge High Tibial Osteotomy Decreases Medial Meniscal Extrusion and Improves Clinical Outcomes and Return to Activity. *Orthop J Sports Med*. 2020;8(4):2325967120913531.
- Brinkman JM, Lobenhoffer P, Agneskirchner JD, Staubli AE, Wymenga AB, van Heerwaarden RJ. Osteotomies around the knee: patient selection, stability

of fixation and bone healing in high tibial osteotomies. *J Bone Joint Surg Br.* 2008;90(12):1548-57.

13. Gupta A, Tejpal T, Shanmugaraj A, Horner NS, Simunovic N, Duong A, et al. Surgical Techniques, Outcomes, Indications, and Complications of Simultaneous High Tibial Osteotomy and Anterior Cruciate Ligament Revision Surgery: A Systematic Review. *HSS J.* 2019;15(2):176-84.

14. Polacek M, Nyegaard CP, Høien F. Day-Case Opening Wedge High Tibial Osteotomy with Intraosseous PEEK Implant. *Arthrosc Sports Med Rehabil.* 2020;2(2):145-51.

15. Roberson TA, Momaya AM, Adams K, Long CD, Tokish JM, Wyland DJ. High Tibial Osteotomy Performed With All-PEEK Implants Demonstrates Similar Outcomes but Less Hardware Removal at Minimum 2-Year Follow-up Compared With Metal Plates. *Orthop J Sports Med.* 2018;6(3):2325967117749584.

16. Chieh Szu Yang J, Chen CF, Lee OK. Benefits of opposite screw insertion technique in medial open-wedge high tibial osteotomy: A virtual biomechanical study. *J Orthop Translat.* 2020;20:31-6.

17. Sarman H, Isik C, Uslu M, Inanmaz ME. High Tibial Osteotomy Using a Locking Titanium Plate With Or Without Autografting. *Acta Ortop Bras.* 2019;27(2):80-4.

18. Belsey J, Dikko Kaze A, Jobson S, Jobson S, Faulkner J, Maas S, Khakha R, et al. Graft materials provide greater static strength to medial opening wedge high tibial osteotomy than when no graft is included. *J Exp Orthop.* 2019;6(1):13.

19. Chuaychoosakoon C, Parinyakhup W, Kwanyuang A, Duangnumswang Y, Tangtrakulwanich B, Boonriong T. Coronal Alignment Correction and Maintenance of Tibial Slope in Opening-Wedge Valgus High Tibial Osteotomy Using a 4-Reference Kirschner Wire Technique: A Cadaveric Study. *Orthop J Sports Med.* 2020;8(6):232596712092360.

20. Tekin SB, Arpacioğlu MÖ. Comparison of the clinical and radiological results of posterior cruciate ligament-retaining and posterior cruciate ligament-stabilized knee arthroplasties. *Ann Clin Anal Med.* 2021;12(06):617-20.

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